Citation:

Field AE, Gillman MW, Rockett HR, Colditz GA. Association between fruit and vegetable intake and change in body mass index among a large sample of children and adolescents in the United States. *Int J Obesity.* 2003; 27: 821-826.

PubMed ID: 12821968

Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To assess whether intake of fruits and vegetables and fruit juice were associated with change in body mass index (BMI) among a large sample of children and adolescents in the United States.

Inclusion Criteria:

- Girls and boys who were nine to 14 years of age in 1996
- Children who completed at least two Growing Up Today Study (GUTS) questionnaires between 1996 and 1999.

Exclusion Criteria:

- Children who completed fewer than two GUTS questionnaires between 1996 and 1999
- Children who reported consuming less than 500 or greater than 5,000 calories
- Children who reported an average of more than 40 hours per week of physical activity
- Children who reported an average of more than 80 hours per week of inactivity.

Description of Study Protocol:

Recruitment

- The Growing Up Today Study (GUTS) was established in 1996 by recruiting children, nine to 14 years of age, of women participating in the Nurses' Health Study II (NHS II)
- Using NHSII data, women who had children ages nine to 14 years were identified and detailed letters were sent to these women explaining the purpose of the GUTS and seeking consent to enroll their children
- Letters and baseline questionnaires were mailed to children whose mothers gave consent
- Questionnaires were mailed to 13,261 girls and 13,504 boys; 68% of girls (N=9,039) and 58% of boys (N=7,843) returned completed questionnaires.

Design

Prospective cohort study.

Dietary Intake/Dietary Assessment Methodology

Dietary intake was assessed with the Youth/Adolescent Questionnaire (YAQ), a self-administered semi-quantitative food-frequency questionnaire (FFQ) assessing intake of 131 foods over the past year.

Blinding Used

Not reported.

Intervention

Not applicable.

Statistical Analysis

- Conditional linear models, which allow for variation in the time between exposure assessments, were used for all multivariate analyses. All models assessing the association between intake of fruit, fruit juice, vegetables and weight change over a one-year period controlled for age, age squared, Tanner stage, activity, inactivity, age- and gender-specific z-score of BMI at baseline, and height change over the one-year interval
- Linear regression models controlling for energy intake were run to determine whether the effect of fruit and vegetable intake was because of differences in total calorie intake
- Fruit and vegetable intake were modeled as continuous variables in the analyses and both fruit and vegetable intake at the beginning of the one-year period and change in intake over the year included as covariant in the models
- All P-values are two-sided, and $P<0.05$ was considered to be statistically significant.

Data Collection Summary:

Timing of Measurements

Dietary intake, physical activity, inactivity, Tanner stage, weight, and height were assessed annually from 1996 to 1999.

Dependent Variables

Weight Status: Determined using BMI that was calculated using self-reported height and weight and was based on age- and gender-specific CDC growth charts.

Independent Variables

Fruit, vegetable and fruit juice intake were assessed with the Youth/Adolescent Questionnaire (YAQ), a self-administered semi-quantitative FFQ assessing intake of 131 foods over the past year.

Control Variables

- Age
- Age squared
- Tanner stage
- Activity
- Inactivity
- Age- and gender-specific z-score of BMI at baseline
- Height change over the one-year interval
- Total energy intake.

Description of Actual Data Sample:

- *Initial N*: 9,039 girls and 7,843 boys returned completed questionnaires in 1996
- *Attrition (final N):* N=8,203 girls and N= 6,715 boys who were ages nine to 14 years in 1996 and completed at least two GUTS questionnaires between 1996 and 1999

Subject Characteristics at Baseline

	Girls (N=8,203)	Boys (N=6,715)
Age (years)	12.0±1.6	11.8±1.5
BMI (kg/m^2)	19.0±3.3	19.1±3.3
Percentage Overweight	12.7%	14.6%
Percentage Obese	4.9%	8.4%

- *Ethnicity:* Not reported
- *Other relevant demographics:* None reported
- *Location:* United States.

Summary of Results:

Baseline Dietary Intake Data

	Girls (N=8,203)	Boys (N=6,715)
Fruit (including juice)	1.9±1.3	1.8±1.3
Fruit not including juice	1.0±0.8	1.0±0.8
Juice	0.8±0.8	0.9±0.9
Vegetables	1.6±1.0	1.5±1.0
Vegetables not including french fries	1.5±1.0	1.4±1.0
Vegetables not including potatoes	1.3±0.9	1.2±0.9
Fruits and vegetables	3.4±2.0	3.3±2.0
Percentage consuming two servings per day of fruits and vegetables	22.2%	23.5%

Percentage consuming three servings per day of fruits and vegetables	21.1%	19.4%
Percentage consuming four servings per day of fruits and vegetables	16.6%	16.3%
Percentage consuming five or more servings per day of fruits and vegetables	23.6%	22.2%
Total Calories (kcal)	2,050±647	2,290±714

- During three years of follow-up, annual changes in BMI were slightly greater among the boys than among the girls (0.7-0.8 units per year for boys vs. 0.6-0.7 units per year for girls)
- On average, girls and boys consumes slightly fewer than two servings of fruit per day, of which almost 50% was in the form of juice
- Participants consumed fewer servings of vegetables than fruit per day; about 0.3 servings per day were attributed to potatoes
- Fewer than 25% of the participants were meeting the recommendation to consume at least five servings of fruits and vegetables per day.

Relationship between Fruit, Vegetable and Fruit Juice Intake and Weight Status

- There were no significant associations between intake of fruits, fruit juice or vegetables (alone or combined) and subsequent changes in BMI z-score among girls (adjusted for Tanner stage, age, height change, activity and inactivity)
- Among boys, intake of fruit and fruit juice was not predictive of changes in BMI; however, vegetable intake was inversely associated to changes in BMI z-score ($\beta = -0.003$). However, this was no longer significant after data was adjusted for total energy intake.
- After adjusting for total energy intake, fruit intake ($\beta=0.003$ for girls and $\beta=0.002$ for boys) was predictive of having a slightly larger BMI z-score at the end of the follow-up period.

Author Conclusion:

- Neither fruit or juice intake predicted changes in BMI, but among males, vegetable intake was inversely related to changes in BMI z-score. The benefits of vegetables, however, was diminished and no longer significant once total energy intake was included in the statistical model. The authors propose that diets high in vegetables may have been lower in calories, and it was the calories, not vegetables, that were inversely predicting changes in BMI z-score
- After adjusting for total energy intake, there was a suggestion that a diet rich in fruit might lead to larger gains in relative weight; however, the effect was very modest.

Reviewer Comments:

- *BMI was used as a surrogate measure of adiposity*
- *BMI was calculated on children's self-reported height and weight*
- *The study sample was not a random sample of US children and adolescents, limiting the generalizability of the results*
- *Fruit and vegetable intake was analyzed without taking into account other dietary patterns.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	N/A
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes

3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	No
4.4.	Were reasons for withdrawals similar across groups?	???
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes

6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	No
6.6.	Were extra or unplanned treatments described?	No
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	No
7.5.	Was the measurement of effect at an appropriate level of precision?	???
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	No
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes

8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes